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March 16, 1973

ERTS Program Manager
Code ER
NASA Headquarters
Washington, D.C. 20546

RE: Contract No. NAS5-21795 GFSC ID ST 355

Dear Sirs:

The Indiana Geological Survey and EarthSatellite Corporation (EarthSat) are pleased to submit a progress report for the period of January 1, 1973 to March 1, 1973. To facilitate for review by NASA a consistent summary format has been adopted for month to month reporting.

A. TITLE: Study of Application of ERTS-A Imagery to Fracture-Related Mine Safety Hazards in The Coal Mining Industry.

B. PRINCIPAL INVESTIGATOR: Dr. Charles E. Wier (SR #325)

C. CO-PRINCIPAL INVESTIGATOR: Dr. Frank J. Wobber

D. PRINCIPAL CONTRIBUTORS: Dr. Charles E. Wier
Mr. Orville R. Russell
Mr. Roger Amato

E. SUMMARY OF ACCOMPLISHMENTS:

- A Data Analysis Plan was submitted in January and approved on February 16, 1973.
- A Type II (six month) progress report has been submitted.
- Three test sites for intensive investigations to validate the theoretical basis for the program are under study.

These are (1) The Thunderbird Mine of (Sullivan County); (2) The King Station Mine (Gibson County) and (3) The Mecca Mine area (Parke County). All three sites are areas of underground coal mining. Surface Mines deserving special study will be selected at a later date.

- Comparison of ERTS/high altitude aircraft-derived fracture data with sites of underground mining problems is continuing as follows:

  (1) Data relating to rock falls and fracturing in the King Station Mine is being acquired. A visit to the mine is planned.

  (2) Investigations have started on the Thunderbird Mine in Sullivan County where considerable data has been compiled on roof falls and fracturing. This mine was closed in 1972 because of severe roof fall problems.

F. SIGNIFICANT RESULTS:

The utility of ERTS-1/high altitude aircraft imagery to detect underground mine hazards is strongly suggested. A 1:250,000 scale mined lands map of the Vincennes Quadrangle, Indiana has been prepared. This map is a prototype for a national mined lands inventory and will be distributed in March to State and federal offices.

G. PROBLEMS:

Retrospective requests for CCT's and color composite imagery, placed in October have yet to be honored. Standing order changes are requiring over four months to be initiated.

H. RECOMMENDATIONS FOR TECHNICAL CHANGES:

Interest in mined lands studies using ERTS has increased in Indiana State offices. A gob pile inventory should be conducted as a change to the existing program.

I. CHANGES TO STANDING ORDER FORMS:

The change request made in October for the addition of 9 1/2" X 9 1/2" positive transparencies to the standing order has not been added to the NDPF standing order.

J. OVERVIEW OF INVESTIGATION:

The utility of ERTS imagery for regional fracture detection has been demonstrated and substantial new structural data has been acquired over the Illinois Basin. Fracture data from ERTS imagery and high-altitude aircraft photography correlates well with mine accident data and additional studies to more firmly establish the validity of the investigation are underway. Detailed fracture analysis of the Thunderbird Mine area in Sullivan county has begun. A significant quantity of data related to environmental monitoring of coal-mined lands has been generated from ERTS-1 imagery. The capability of ERTS to monitor monthly changes in mined lands has been established.

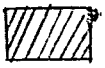
Sincerely yours,

Frank J. Wobber
Director
Geosciences and Environmental
Applications Division

FJW/lal

TASK STATUS REPORT

Contract # NAS5-21795

 = Completed Tasks

TASK		STATUS	COMMENTS
PHASE II FIRST LOOK ANALYSIS			
1.0	RECONNAISSANCE ANALYSIS OF ERTS-1 IMAGERY		
1.1	PREPARE ERTS BASE MAP	COMPLETE	An ERTS Imagery photo-base map has been prepared at a scale of 1:250,000 for the area corresponding to the Vincennes, Indiana 1:250,000 scale topographic sheet. A National Mined Lands map phototype was prepared using the base map. Others maps are being prepared as suitable (cloud free) imagery becomes available.
1.2	ANNOTATE BASE MAP WITH HAZARDS DATA	UNDERWAY	Various data relating to coal mining hazards are being compiled on a base map. These data include incidents of rooffalls resulting in miner deaths, and evidence of changing mine drifts indicative of weak roof.
1.3	PRELIMINARY ERTS-1 IMAGERY ANALYSIS	COMPLETE	ERTS-1 imagery has been analyzed for fracture lineaments. This will be a continuing effort. A fracture validation system (see Task 2.0, continuing data analysis) has been adopted.
1.4	RANK ERTS-1 SPECTRAL BANDS	COMPLETE	The utility of individual spectral bands for mine hazards investigations has been established by EarthSat based on imagery during the summer season and good fall coverage. This assessment will continue throughout the year. NOTE: Based on imagery to date, MSS Bands 5 and 7 appear to be most useful for fracture discrimination purposes.

TASK		STATUS	COMMENTS
PHASE II (Cont'd)			
2.0	PRELIMINARY COMPARISON OF ERTS-1 LINEAMENTS AND KNOWN HAZARDS DATA	COMPLETE	Within the Indiana coal field the greater quantity of lineaments identified on ERTS imagery occur north of Terre Haute. A test site has been selected for special study in Parke County where underground mining is present. King State Mine was studied.
3.0	INITIAL TESTING OF FRACTURE ANALYSIS TECHNIQUES		
3.1	MANUAL ANALYSIS	COMPLETE	The various standard manual analysis techniques apply equally well to ERTS imagery as to aerial photography. Scan line traces tend to obscure lineaments parallel to traces. Both ERTS-1 imagery and small scale photography were applied to mapping geological lineaments.
3.2	FILM SANDWICH	UNDERWAY	Standard film sandwich edge enhancement techniques have not been used extensively due to quality of ERTS negatives and due to availability of electro-optical instrumentation which accomplishes same results.
3.3	COMPUTER-ASSISTED	UNDERWAY	Fracture trace angle measurement and rosette plotting by computer are being programmed.
3.4	OPTICAL/ ELECTRO-OPTICAL	COMPLETE	Additive color and density slicing techniques are being used as required.

TASK		STATUS	COMMENTS
PHASE II (Cont'd.)			
4.0	GENERAL ANALYSIS OF NASA AIR-CRAFT IMAGERY	COMPLETE	First analysis of the 1:120,000 scale color infrared (corn blight) photography as a complement to ERTS-1 imagery has been completed Fracture lineaments were identified in selected study areas using a validation system.
5.0	TEST ERTS-1/ AIRCRAFT IMAGERY TO PROBLEMS OF MINING AND ENVIRONMENT	COMPLETE	Mined land (environmental) information is available from ERTS imagery. The extent of surface mining activity, resultant water bodies, large refuse piles and slurry ponds are being identified. An updated inventory of mined lands was completed by IGS and EarthSat.
6.0	PREPARE AND SUBMIT DATA ANALYSIS PLAN	COMPLETE	Submitted and approved.

TASK		STATUS	COMMENTS
PHASE III CONTINUING DATA ANALYSIS			
1.0	CONTINUE APPLICATION OF ERTS-1/ AIRCRAFT OF MINING-ENVIRONMENT STUDIES	UNDERWAY	National prototype for mined land inventory has been prepared (Vincennes Quadrangle, Indiana).
2.0	ESTABLISH FRACTURE VALIDATION SYSTEM	COMPLETE	A preliminary validation system has been prepared by EarthSat. Following testing, it will be revised and finalized.
3.0	CONDUCT DETAILED ANALYSIS OF ERT-1/ AERIAL PHOTOGRAPHY	UNDERWAY	High altitude (1:120,000) scale aerial photography and all ERTS-imagery is now being analyzed. Reconnaissance analysis of data from NASA aircraft mission No. 210 is continuing.
4.0	CONSOLIDATE FRACTURE DATA	UNDERWAY	Plans to consolidate fracture data (reduce overlays, etc. to common base) have been made.
5.0	COMPARE UNDERGROUND SURFACE MINE ACCIDENT DATA TO FRACTURE ZONES	UNDERWAY	Attention is being given to the Thunderbird Mine in Sullivan County where considerable fault and rooffall data has been assembled by the Principal Investigator.
6.0	DELIMIT HAZARDOUS ZONES IN ACTIVE/ ANTICIPATED COAL MINING AREAS	UNDERWAY	Several potentially hazardous areas have been predicted in the King Stations Mine preliminary to a mine visit.

TASK		STATUS	COMMENTS
PHASE III (Cont'd)			
6.1	ESTABLISH CRITERIA FOR DETERMINING HAZARDOUS ZONES	UNDERWAY	Preliminary, areas of numerous joint intersections, high density fractures and isolation of "blocks" by fractures are among the criteria being studied.
6.2	PREPARE MAP OF EVALUATION OF HAZARDOUS ZONES	UNDERWAY	Suitable map scale has been selected.
7.0	DEVELOP PROTOTYPE MINE SAFETY INFORMATION NETWORK		
7.1	VISIT MINE OPERATORS DISCUSS APPLICATIONS OF HAZARDS DATA	UNDERWAY	Plans to visit several mines are being made. (Very preliminary activities)
7.2	ESTABLISH FORMAT FOR MINE SAFET SAFETY DATA DISTRIBUTION		
7.3	DISTRIBUTE MINE HAZARDS MAP		

TASK		STATUS	COMMENTS
PHASE III (Cont'd.)			
8.0	PREPARE FINAL REPORT AND TECHNICAL BRIEFS	UNDERWAY	Final report being prepared as study proceeds. Revised final report outline completed.
9.0	PREPARE COAL INDUSTRY TECHNICAL SEMINAR PROGRAM	UNDERWAY	Early and very preliminary contacts made with industry representation.

PROGRESS REPORT SUMMARY

Reporting Period

January 1, 1973 - February 28, 1973

Category: 3 - Mineral Resources, Geological Structure and Landform Surveys

Sub-Category: L - Mine Safety, Hazard Survey and Disaster Assessment

Title: Study of Application of ERTS-A Imagery to Fracture-Related Mine Safety Hazards in the Coal Mining Industry

Principal Investigator: Dr. Charles Wier

Co-Investigator: Dr. Frank J. Wobber

SUMMARY:

The utility of ERTS-1 and high-altitude aircraft imagery to detect underground mine hazards is strongly suggested by preliminary studies at the King Station Mine in Gibson County, Indiana.

A 1:250,000 scale mined lands map of the Vincennes Quadrangle, Indiana has been prepared. This map is a prototype for a national mined lands inventory and will be distributed in March to state and federal offices.